

REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1-9 in the underlying PCT Application No. PCT/EP2005/050687 and adds new claims 10-20. The new claims, inter alia, conform the claims to United States Patent and Trademark Office rules and do not add any new matter to the application.

In accordance with 37 C.F.R. § 1.125(b), the Substitute Specification (including the Abstract) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to United States Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(ii) and 1.125(c), a Marked-Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) are respectfully requested.

The underlying PCT Application No. PCT/EP2005/050687 includes an International Search Report, dated June 3, 2005, a copy of which is included. The Search Report includes a list of documents that were considered by the Examiner in the underlying PCT application.

It is respectfully submitted that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully Submitted,

KENYON & KENYON LLP
b1 C (in re 3608)
By: *Michelle Carnaby*
Gerald A. Messina
Reg. No. 35,952

One Broadway
New York, NY 10004
(212) 425-7200
(212) 425-5288

CUSTOMER NO. 26646

1184531

10/590617
IAP9 Rec'd PCT/PTO 24 AUG 2006

[10191/4480]

PRESSURE-EFFECTED INTERCONNECTION OF A METAL PART AND A PLASTIC PART

Related Art FIELD OF THE INVENTION

The present invention is based on relates to a pressure-effected interconnection of a metal part and a plastic part which is slipped over the metal part with a press fit, in particular in a fuel 5 injector for internal combustion engines.

BACKGROUND INFORMATION

In a known conventional fuel injector, shown in Figure 1 in longitudinal section, a fuel filter 3 is held by a press fit on 10 a metallic valve housing 1 and a metallic valve body 2 which axially projects from valve housing 1. Fuel filter 3 has a cup-shaped base element 4 which is made of plastic and has four cup sections, 4a, 4b, 4c, 4d, whose inner diameters are graduated with respect to each other. Upper cylindrical cup section 4a, having the largest 15 inner diameter, is slipped over valve housing 1 with a press fit. Second cylindrical cup section 4b, contiguous thereto and having a reduced inner diameter, surrounds the upper region of valve body 2 with a radial clearance and has a wall opening 5 into which a filter mesh 6 is inserted in each case. Third cup section 4c, 20 contiguous to second cup section 4b, tapers conically and, at its lower end, transitions into cylindrical fourth cup section 4d which sits on valve body 2 with a press fit. In the region of conical third cup section 4c, radial inflow ducts 7 are formed in valve body 2, which discharge into a central valve chamber 8 on one side 25 and at the outer wall of valve body 2 on the other side, where they form an intake opening 9 for the fuel flow to valve chamber 8. The

other components of the fuel injector such as valve needle 10 which, together with a valve seat 11, releases or seals a spray-discharge orifice 12 in valve chamber 8, solenoid 13 to actuate valve needle 10, and valve-closure spring 14 are well known, for example from
5 Bosch Kraftfahrtechnisches Taschenbuch, [Automotive Handbook] 23rd edition, 1999, pages 473 and 476, so that there is no need to discuss them further.

In order to achieve appropriate clamping between the valve housing
10 and valve body on one side and the plastic filter on the other side, and also reliable mounting, close tolerances of the parts to be interconnected by compression must be observed, and the plastic part must be subjected to special conditioning. If the compression is too high, the plastic base element of the fuel filter may be
15 damaged or destroyed during the pressing-on operation. If the compression force is too low, the filter may detach easily since the base element made of plastic has a different thermal expansion coefficient than the metal of valve housing and valve body. Swelling of the plastic may also cause expansion of the base element
20 so that the water content of the plastic must be adjusted to a specific value by conditioning the plastic base element.

Summary of the Invention

25 SUMMARY
In contrast, the A pressure-effectuated interconnection of a metal part and a plastic part according to an example embodiment of the present invention has may have the advantage that it requires no close manufacturing tolerances between the two parts to be pressed
30 together, and that a reliable press fit of the plastic part on the metal part as well as reliable assembly are guaranteed under all operating conditions, also without special conditioning specifications having to be observed for the plastic part. Shavings possibly peeling off the plastic part during compression are caught
35 in the annular grooves sunk into the wall of the metal part at the

foot of the ribs, and are unable to squeeze between the contact surfaces of the pressing pieces, thereby bringing about an undefined pressing surface. The force characteristics during the assembly, i.e., the slide-on force, is constant across a longer 5 production period and exhibit only slight variances, which makes them easy to monitor.

~~Advantageous further refinements and improvements of the pressure effected interconnection indicated in Claim 1 are rendered possible by the measures specified in the additional claims.~~

According to an advantageous embodiment of the present invention, the ribs situated one behind the other are formed such that their 15 projection height beyond the wall of the metal part - viewed transversely to the slide-on direction of the plastic part - increases in the slide-on direction of the plastic part, that is to say, the first rib lying closer to the plastic part in the slide-on direction has a lower projection height than the last rib 20 lying at a greater distance from the plastic part in the slide-on direction. This design of the ribs ensures a slow increase in the compression when the plastic part is slipped over the metal part.

A fuel valve, in particular a fuel injector for internal combustion 25 engines, is ~~indicated in Claims 5 through 9, also provided,~~ where the pressure-effected interconnection according to the present invention is established between the valve body representing a metal part and a fuel filter representing a plastic part.

30 ~~Brief Description of the Drawing~~

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is explained in greater detail in the following description on the basis of an exemplary embodiment shown 35 in the drawing. The figures show:.

~~Fig. 1-A shows a longitudinal section of a conventional fuel injector according to the related art.~~

Fig. 2-A shows a longitudinal section of a fuel injector according to an example embodiment of the present invention in a cutaway view.

5 ~~Detailed Description of the Exemplary Embodiment~~

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENT

The pressure-effectuated interconnection of a metal part and a plastic part slid over the metal part with a press fit is described in the following with the aid of a fuel injector for internal combustion engines on whose metallic valve body 22 a fuel filter 23 made of plastic is held with a press fit. ~~As in the case of the fuel injector described in Figure 1 in connection with the related art, the~~ The fuel injector shown only in a cutaway view in Figure 2 in a longitudinal section has a cylindrical valve body 22 in which a valve chamber 28 and at least one inflow duct 27 for the supply of fuel into valve chamber 28 are formed. Inflow ducts 27, of which only one can be seen in Figure 1, discharge into valve chamber 28 on one side and have an inflow opening 29 in the outer wall of cylindrical valve body 22 on the other side. While not shown further, but matching the fuel injector according to Figure 1, valve chamber 28 has a valve opening, or spray bore, which is enclosed by a valve seat. Valve needle 30, shown in a cutaway portion in Figure 2, dips into valve chamber 28 and - as in Figure 1 - is pressed onto the valve seat by a valve-closure spring, thereby closing the valve opening. As in Figure 1, valve needle 30 is actuated by a solenoid, which in response to being supplied with an excitation current lifts valve needle 30 off the valve seat, counter to the force of the valve-closure spring, so that the valve opening is released and fuel is spray-discharged from valve chamber 28. The solenoid is in turn accommodated in valve housing 21. Valve body 22 is inserted into valve housing 21 from below and connected to valve housing 21 in the region of a valve-body section having a larger diameter in a fluid-tight manner by a circumferential welded seam

31. In the process, an annular chamber 32 into which inflow ducts 27 discharge by way of their inflow openings 29 is produced between inner wall 211 of valve housing 21 and cylinder wall 221 of valve body 22. The fuel flow to valve chamber 28 is implemented via 5 annular chamber 32 and inflow ducts 27.

Fuel filter 23 has a hollow-cylindrical base element 24 made of plastic whose inside diameter is slightly larger than the outer diameter of valve body 22. Wall cutouts, i.e., traversing wall 10 openings 25 via which inflow ducts 27 are connected to annular chamber 34, are introduced into base element 24. Each wall opening 25 is covered by a filter mesh 26. Fuel filter 23 is slid over valve body 22 in the direction of arrow 33.

15 To achieve a reliable, tight press fit of fuel filter 23 on valve body 22 without high demands on the manufacturing tolerances of both components, a plurality of circumferential ribs - in this case, three ribs 34, 35, 36 - have been formed on cylinder wall 221 of valve body 22, which are arranged one behind the other in the axial 20 direction of valve body 22, i.e., in slide-on direction 33 of fuel filter 23. Each circumferential rib 34, 35, 36 has a back 37 which radially rises in slide-on direction 33 of fuel filter 23, and a flank 38 which sharply falls from the back end, radial flank 38 extending radially in the exemplary embodiment of Figure 2. As can 25 be seen from Figure 2, the radial projection height of ribs 34, 35, 36 increases in slide-on direction 33 of fuel filter 23, so that first rib 34 has the smallest projection height and thus the smallest radial measure of flank 38, and last rib 36 has the greatest projection height and thus the greatest radial measure 30 of flank 38. Situated in front of each rib 34, 35, 36 in slide-on direction 33 of fuel filter 23 is an annular groove 39, which is introduced into cylinder wall 221 directly at the foot of back 37.

During installation fuel filter 23 is pressed over ribs 34 through 36 by its base element 24 made of plastic. The pressing over of ribs 34 through 36 is facilitated by the angled slope of back 37. The stepped increase in the projection measure of ribs 34 through 5 36 beyond cylinder wall 221 ensures a slow increase in the pressure. The pressure itself acts directly on ribs 34 through 36, as line contact and not across the full pressure path, which causes base element 24 to deform slightly. In addition, base element 24 is subjected to a locally high line pressure, which is more 10 advantageous for the plastic base element than cylindrical loading. When fuel filter 23 is completely pressed onto valve body 22, base element 24 interlocks with ribs 34 through 36. Shavings and scrapings of plastic that may detach when base element 24 is pressed on may collect in annular grooves 39 at the foot of back 37 of ribs 15 34 through 36 and will not be pushed toward the outside. This also prevents the plastic shavings or splinters from being pushed through the gap between base element 24 and valve body 22 so that they do not become wedged there. They are also unable to reach the area of inflow ducts 27 and be washed into the valve seat region 20 by the fuel via inflow ducts 27.

The present invention is not limited to the exemplary embodiment of a fuel injector shown and described in Figure 2. Naturally, it It is also possible to implement the press fit between fuel filter 25 323 according to Figure 1 on the one side, and valve housing 1 and valve body 2 on the other side, in the manner described.

The pressure-effected interconnection according to the present invention of a metal part and a plastic part slid over the metal 30 part with a press fit, which was described using the example of a fuel injector, may generally be used for any plastic-metal part interconnection.

~~Abstract~~ABSTRACT

A pressure-effectuated interconnection of a metal part and a plastic part which is slipped over the metal part with a press-fit, in particular in a fuel injector for internal combustion engines, is provided in which, for a reliable connection between the pressing pieces, without high demands on manufacturing tolerances, the outer wall of the metal part has circumferential ribs (34, 35, 36) disposed one behind the other in the axial direction, with a back (37) that rises from the outer wall (221) towards the outside in the slide-on direction (33) of the plastic part, and a flank (38) that falls steeply from the back (37) to the outer wall (221). Each rib (34, 35, 36) has disposed in front of it - viewed in the slide-on direction (33) of the plastic part - an annular groove (39), the annular groove (39) being introduced into the outer wall (221), directly at the foot of the back (37). (Figure 2).